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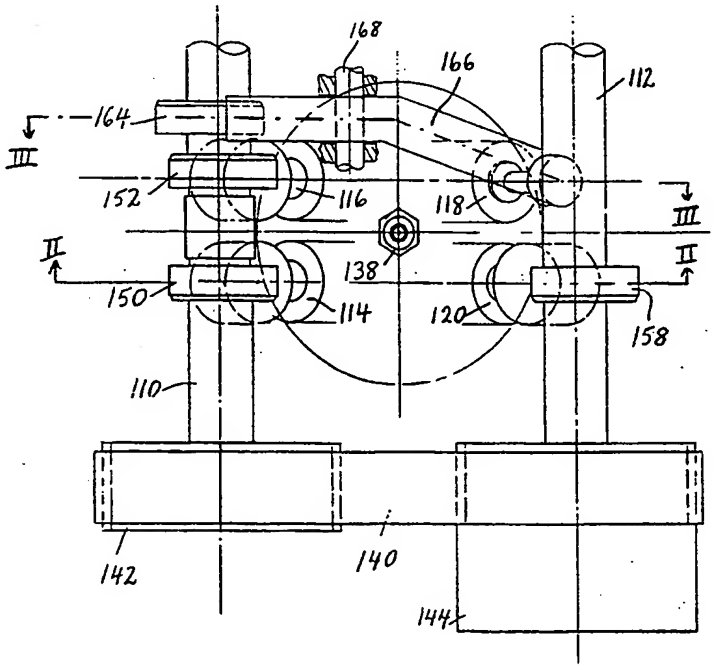
(54) Title: TWIN CAM MULTI-VALVE INTERNAL COMBUSTION ENGINE



(57) Abstract

A twin cam engine is described having a primary and a secondary inlet valve (118, 120) for each engine cylinder and means (144) for varying the opening phase of the secondary inlet valves (120) relative the primary inlet valves (118). The first of the overhead camshafts (110) is provided with cams (150, 152, 164) for all the exhaust valves (114, 116) and the primary inlet valves (118) and the second camshaft (112) is formed with cams (158) for only the secondary inlet valves (120), whereby phase shifting of the second camshaft (112) relative to the first camshaft (110) causes a phase shift between the secondary inlet valves and the primary inlet valves without affecting the exhaust event.

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TWIN CAM MULTI-VALVE INTERNAL COMBUSTION ENGINE

Field of the invention

The invention relates to a twin cam engine having a primary and a secondary inlet valve for each engine cylinder and means for varying the opening phase of the secondary inlet valves relative the primary inlet valves.

Background of the invention

It is has been proposed in EP-A-0 262 769 that by allowing the inlet valve to remain open during part of the compression stroke of a four stroke engine, it is possible to reduce the trapped mass of the charge and thereby achieve part load performance without throttling the intake passage. This can be achieved in the case of an engine with two intake valves per cylinder by introducing a major phase shift between the two inlet valves.

In known combustion engines of the type having three or four valves per cylinder operated by twin camshafts, it is usual for there to be an inlet camshaft controlling all the inlet valves and an exhaust camshaft for the exhaust valves. If in such a lay out, one wishes to vary the phase of the secondary inlet valves relative to the primary inlet valves, then concentric cams are required which makes for a complicated and expensive construction. The strength of the camshafts is also impaired, tending to reduce the engine reliability.

GB-PS-347,806 describes an engine in which each cylinder has two pairs of valves arranged at the four corners of a square, the valves of each pair being symmetrically arranged about the engine centre line. Two overhead camshafts are provided each operating one inlet and one exhaust valve, and the camshafts can be phase shifted relative to one another in order to vary the duration of

the intake and exhaust events. In this prior art proposal, it is not possible to vary the inlet event without varying the exhaust event. If the intake event is to be prolonged sufficiently to permit part of the intake charge to be expelled, then this can only be done by prolonging the exhaust event by the same amount. This would inevitably lead to excessive valve overlap which would cause increased internal exhaust gas recirculation and the undesirable presence of an excess of exhaust gases in the induced charge.

Object of the invention

The present invention seeks to provide an engine in which the phasing of second intake valve can be regulated to vary the intake event duration without affecting the exhaust event.

Summary of the invention

According to the present invention, there is provided a twin cam engine having a primary and a secondary inlet valve for each engine cylinder and means for varying the opening phase of the secondary inlet valves relative the primary inlet valves, wherein the first of the overhead camshafts is provided with cams for all the exhaust valves and the primary inlet valves and the second camshaft is formed with cams for only the secondary inlet valves, whereby phase shifting of the second camshaft relative to the first camshaft causes a phase shift between the secondary inlet valves and the primary inlet valves without affecting the exhaust event.

It is possible for the layout of the ports to be conventional, that is to say with all the inlet valves lying on one side of the engine and the exhaust valves on the other. In this case, the cams on the first camshaft can act on the primary inlet valves by way of rockers.

Such a configuration is however difficult to achieve because of packaging problems and it is preferred that the valves on one side of the engine should be the secondary valves operated directly by the second camshaft and that both the exhaust valves and the primary inlet valves should be arranged along the other side of the engine for operation by the first camshaft.

In the latter case, the intake ports for the primary valves should preferably cross the engine centre line to the same side as the intake ports for the secondary inlet valves in order to enable conventional inlet and exhaust manifolds to be employed. The primary and secondary valve of an individual cylinder may, if necessary, share the same duct but alternatively it is possible to provide separate ducts for each valve opening on to the same side of the engine.

It is preferred to provide only a single exhaust valve per cylinder as the provision of four valves makes location of the spark plug troublesome. It is however possible to provide two exhaust valves per cylinder and in this case the exhaust valves preferably share a common exhaust port which may be bent to afford space for the spark plug.

Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which :

Figure 1 shows a schematic plan view of one cylinder of an internal combustion engine of the invention,

Figure 2 is a section along the line II in Figure 1,

Figure 3 is a section along the line III-III in Figure 1,

Figure 4 is a schematic representation of the cylinder head of a second embodiment of the invention,

Figure 5 is a similar view of third embodiment of the invention, and

Figure 6 is a schematic drawing showing the preferred arrangement of the ports in an engine having four valves per cylinder.

Description of the preferred embodiments

Figures 1 to 3 show partially an engine having two overhead camshafts 110, 112 and four valves 114, 116, 118 and 120 per cylinder. The valves 114, 116 are exhaust valves and the valve 118, 120 are primary and secondary intake valves, respectively. A spark plug 138 is arranged centrally between the four valves.

The first camshaft 110 is directly driven by the crankshaft through a toothed belt 140 passing over a toothed wheel 142. The first camshaft has cams 150 and 152 which act on the exhaust valves 114, 116 through cam follower buckets 156. The second camshaft 112 is driven by the toothed belt 142 through a phase change mechanism 144 which may comprise any suitable linkage to permit the second camshaft 112 to rotate relative to the first camshaft 110. The second camshaft 112 has a cam 158 which acts on the follower 162 of the secondary intake valve 120.

The primary intake valve is driven by a third cam 164 on the first camshaft 110 through a rocker 166 which is pivoted either on a shaft 168 (as shown) or on a post. In this way, the relative phasing of the primary inlet valve 118 is fixed but the phasing of the secondary intake valve can be varied by the phase change mechanism 144.

Figure 4 shows schematically one cylinder of a multi-cylinder engine having twin overhead camshafts 10 and 12 and three valves per cylinder. The camshaft 10 passes over the valves of the exhaust ports 14 and the primary intake ports 16. The camshaft 12 on the other hand passes over the second intake ports 18 and over the spark plug holes 20. In this case, all the valves are operated directly by cams mounted on the respective camshafts 10 and 12, the primary intake valves and the exhaust valves being operated by cams on the camshaft 10 and the secondary intake valves being operated by the cams on the camshaft 12.

It is usual to have in an engine an exhaust manifold on one side and an intake manifold on the other. It is therefore preferred that both intake ports should enter the cylinder head from the same side of the engine. In the case of the embodiment of Figure 4, the intake ports branch off from the same intake duct 22. In the embodiment of Figure 5, on the other hand, two separate intake ducts 24 and 26 lead to the respective intake ports 16, 18 from the same side of the engine. It will also be noted that in Figure 5 the two intake ports are of unequal size.

In the case of the embodiment of Figure 6, as with the embodiment of Figures 1 to 3, each of the cylinders has two exhaust valves 30, 32 and two intake valves 34, 36. The spark plug 38 is arranged centrally between all four ports. The exhaust ports of each cylinder lie on opposite sides of the engine centre line as do the intake ports. One of the camshafts in this embodiment must control both exhaust ports and the primary intake ports while the other camshaft controls only the secondary intake ports. Because the exhaust valves are arranged on opposite sides of the engine centre line, one of the exhaust valves must be operated indirectly, such as by means of a rocker as earlier described.

In the three valve embodiments of Figures 4 and 5, the valves have been acted upon directly by the cams and the port arrangement has been modified in order to permit one intake valve and one exhaust valve to be operated by cams on the same camshaft. This however is not essential and it is alternatively possible to resort to a conventional port arrangement with one or two exhaust valves on one side of the engine centre line and two intake valves on the other and to operate one set of intake valves indirectly through the action of rockers following intake cams on the exhaust camshaft. Such an arrangement is not the most preferred from the point of view of ease of manufacture.

In all the described embodiments, if it is desired to use late inlet valve closing in order to reduce the engine volumetric efficiency, then it is only necessary to introduce a phase shift between the two camshafts. The camshafts can be solid and there is no necessity to resort to hollow camshafts.

It is possible either to alter the phase of both camshafts relative to the engine crankshaft or only the phase of the second camshaft 12. In the latter case the exhaust timing remains constant and the effect of the relative phase shift is only to alter the duration of the intake valve opening in each cycle.

CLAIMS

1. A twin cam engine having a primary and a secondary inlet valve (118, 120) for each engine cylinder and means (144) for varying the opening phase of the secondary inlet valves (120) relative the primary inlet valves (118), wherein the first of the overhead camshafts (110) is provided with cams (150, 152, 164) for all the exhaust valves (114, 116) and the primary inlet valves (118) and the second camshaft (112) is formed with cams (158) for only the secondary inlet valves (120), whereby phase shifting of the second camshaft (112) relative to the first camshaft (110) causes a phase shift between the secondary inlet valves and the primary inlet valves without affecting the exhaust event.

2. An engine as claimed in claim 1, wherein the ports are arranged with all the inlet valves lying on one side of the engine centre line and the exhaust valves on the other and wherein cams (164) on the first camshaft (110) act on the primary inlet valves (118) by way of rockers (166).

3. An engine as claimed in claim 1, wherein the primary intake valves are arranged on same side of the engine centre line as the, or one set of, exhaust valves and are directly operated by cams mounted on the first camshaft which includes cams for the exhaust valves.

4. An engine as claimed in claim 3, wherein the intake ducts for the primary valves cross the engine engine centre line to the same side as the intake ducts for the secondary inlet valves.

5. An engine as claimed in claim 4, wherein the primary and secondary intake ports have separate intake ducts opening onto the same side of the cylinder head.

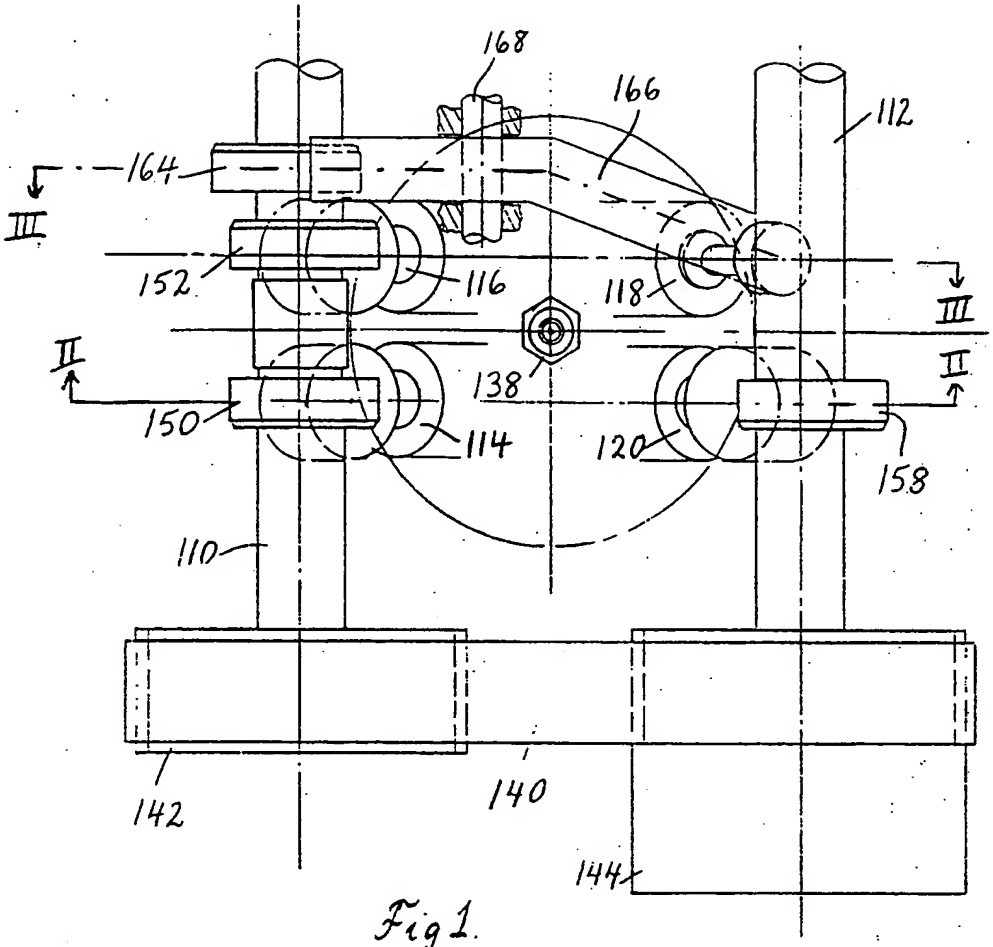
168
166
112
164
III
152
116
118
III
II
138
II
150
114
120
158
110
142
140
144

Fig 1.

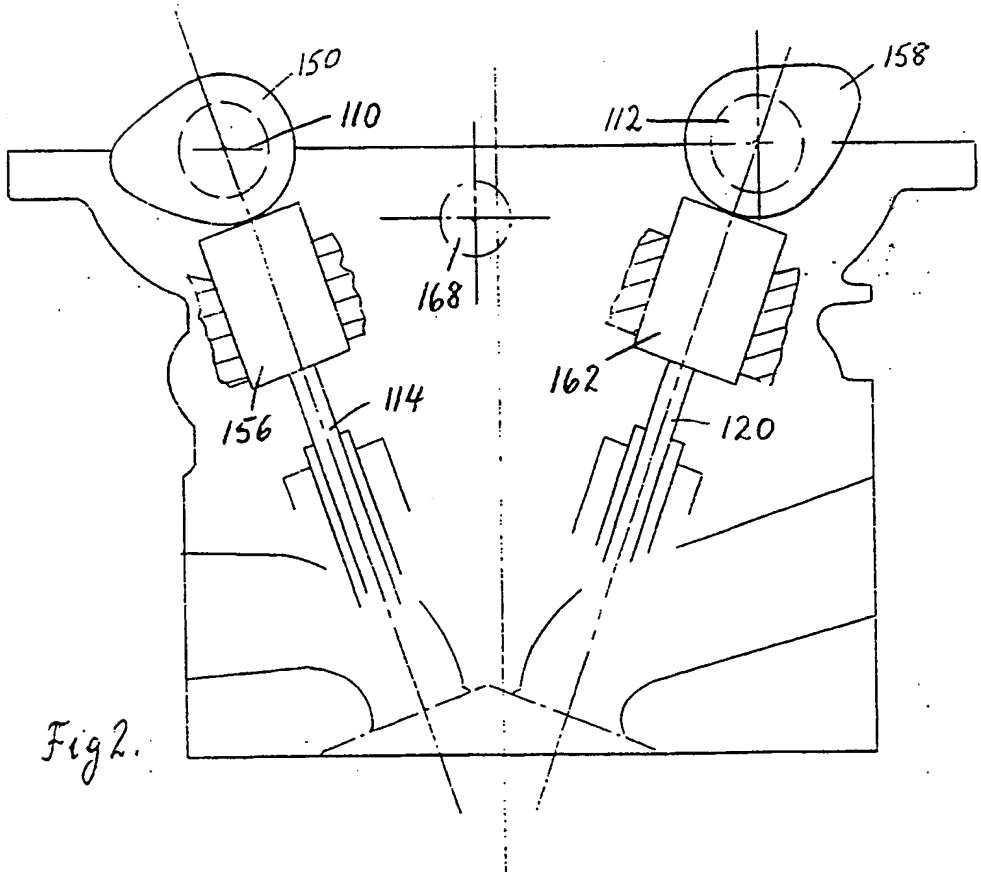
150
110
112
158
168
162
156
114
120

Fig 2.

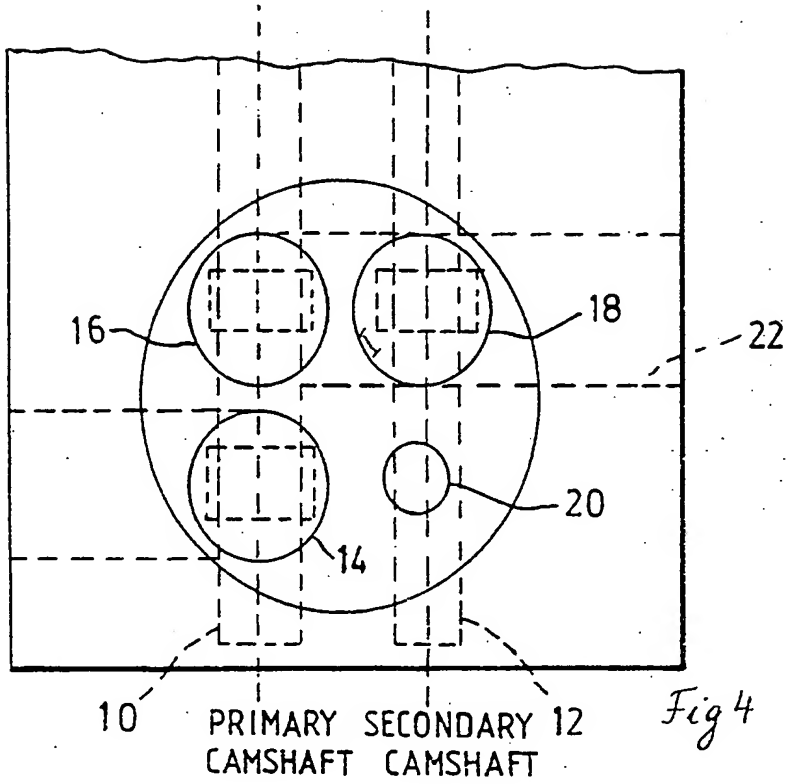
16
18
22
20
14
10
PRIMARY CAMSHAFT
SECONDARY CAMSHAFT
12

Fig 4

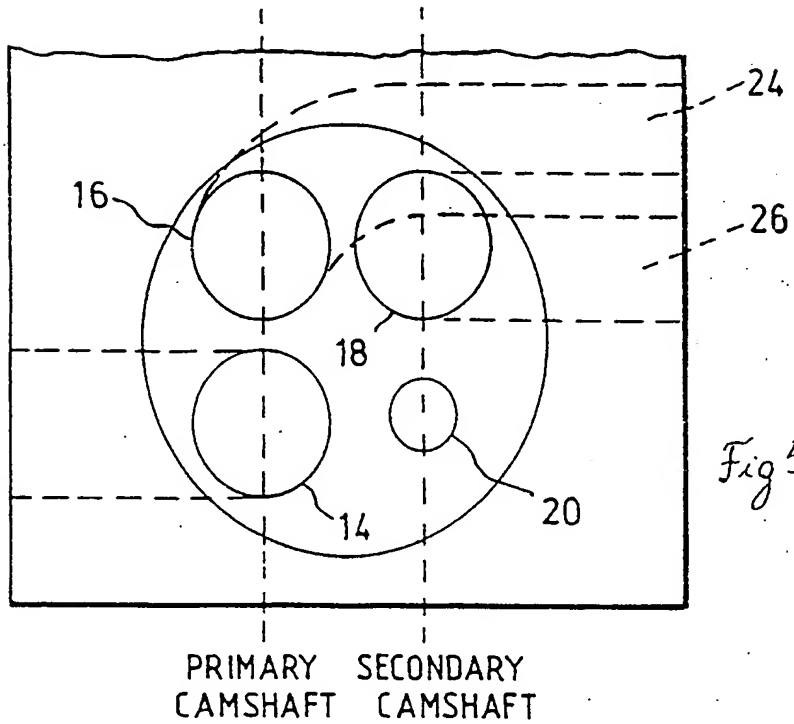
24
16
26
18
14
20
PRIMARY CAMSHAFT
SECONDARY CAMSHAFT

Fig 5

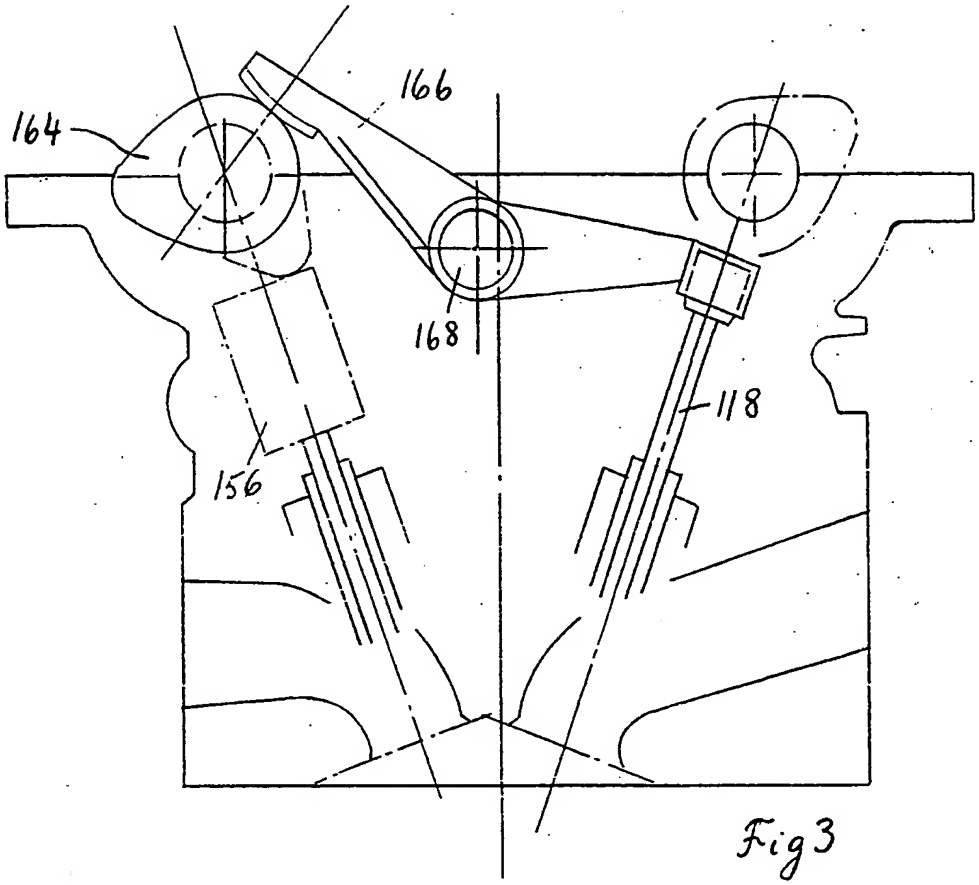
164
166
168
118
156

Fig 3

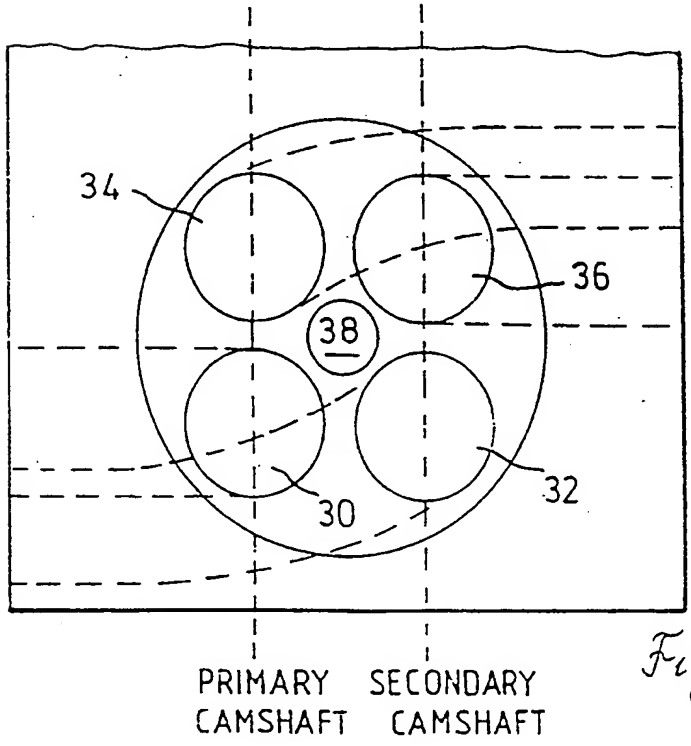
34
36
38
30
32
PRIMARY CAMSHAFT
SECONDARY CAMSHAFT

Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/00269

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F01L1/26 ; F01L1/34

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F01L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	PATENT ABSTRACTS OF JAPAN vol. 10, no. 115 (M-474)(2172) 30 April 1986, & JP-A-60 247008 (MAZDA) 06 December 1985, see the whole document. ---	1, 2
A	EP,A,209426 (PEUGEOT) see page 3, line 10 - page 4, line 3; figures 1-3 ---	3-5
A	DE,A,1751401 (KLAUE) see page 2, lines 13 - 34; figures 1-3 ---	1

* Special categories of cited documents : [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
28 MAY 1990	21. 06. 90

International Searching Authority	Signature of Authorized Officer
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9000269

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-209426	21-01-87	FR-A,B 2584455	09-01-87
		DE-A- 3661092	08-12-88
DE-A-1751401	18-02-71	None	